**ROOF DECKS**
**VENT STACKS**
**VENT CAPS**

Even though vent stack and stack vent terminals extending above roof deck level are components of the sanitary drainage system of the building, they are included for consideration in this section because of roof penetration and roof level maintenance requirements. Vents maintain the air-hydraulic balance of the building's sanitary drainage system and in serving that purpose must be maintained open for positive circulation; i.e., the escape of gas and intake of fresh air. Because of the vent terminals exposure to the elements above the roof, it is vulnerable to fouling by various means-leaves, twigs, bird nests, etc., that somehow have a tendency to become lodged therein. To preclude this undesirable condition protective vent caps that permit free circulation of air while protecting the vent terminal against fouling are recommended.

**Specify Series R1940.**

**ROOF DECKS**
**VANDALISM**
**VANDAL PROOFING**

Because of their "out of building" rooftop location, the exposed components of the roof drainage system, particularly roof drain domes and grates, are subject to vandalism. This is especially true on roofs having easy access. Domes are occasionally removed and at times flung over the roof edge to the detriment of any unfortunate person below. Also, drains congested with debris are rendered useless. To avoid these unlawful damaging circumstances, vandal proofing of roof drain domes and grates is recommended. Vandal proofing is accomplished by securing these components to their fixed mating parts with vandal proof screws or bolts which require special tools, available only to authorized maintenance personnel, for application and removal.

**Specify Suffix -6.**

**Introduction Controlled Flow Roof Drainage**

In the early 1960's, the pervasive industrialization of the post war boom lead to a new problem for plumbing engineers. As more industrial parks, malls, entertainment facilities, factories and warehousing were built, the load on the local storm sewer system due to extensive paved areas surrounding these buildings for parking as well as their own extensive square footage of roof created an unprecedented demand. Where rain once fell on undeveloped land, and was subsequently absorbed or abated by natural drainage, it now fell on pavement, where no absorption factor meant the total rainfall for vast new areas now had to be conducted by municipal storm sewer systems. To avoid overtaxing the local systems, engineers began to be design flat roofs with controlled flow roof drains. Instead of just getting rid of the rain as fast as it fell, the idea was conceived of using the roof itself as a reservoir from which water could be drained off gradually after a storm abated, thus sparing the storm sewer from being overwhelmed. Roofs could then be built with 6" parapets to not only store the rainwater, but also act as wind break against miniature waves that might be caused on the reservoir in high winds with consequent spillage. On buildings with greater than 6" parapets, scupper drains had to be installed at the 5" level to guard against overloading should the drain system fail.

**The Heart of the Controlled Flow Roof Drainage System, The Accuflow Weir**

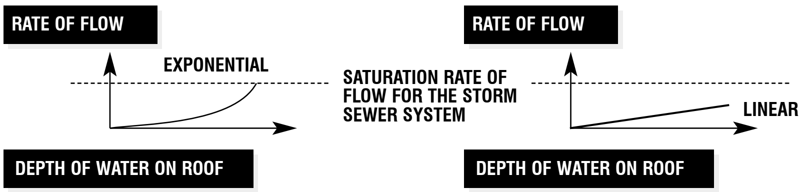
In order to use the roof as a reservoir, it was necessary to design a system where the rate of flow was easily determined for any possible rainfall conditions. The problem is that the rate of flow naturally varies exponentially with the depth of stored water on the roof (a.k.a. head pressure). This made the calculations necessary to design a roof top rain storage system very difficult. **The answer was to design a flow control weir with a parabolic opening which would make the flow off the roof linear instead of exponential.** This meant that once a constant linear flow rate was decided, a weir was designed to admit water to the system at only this fixed rate. The MIFAB system uses a fixed rate of 5 U.S. G.P.M. per inch of water.

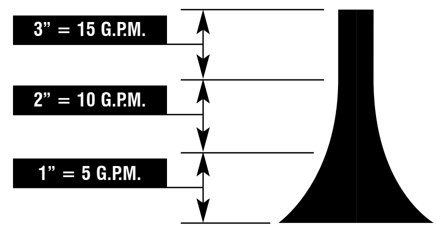
# ACCUFLOW CONTROLLED FLOW ROOF DRAIN SYSTEM

IN AN UNREGULATED SYSTEM, FLOW IS EXPONENTIALLY PROPORTIONAL TO DEPTH OF RAINWATER ON THE ROOF, AND QUICKLY REACHES THE SATURATION POINT OF THE SYSTEM.

IN AN CONTROLLED SYSTEM, FLOW IS LINEARLY PROPORTIONAL TO DEPTH OF RAINWATER ON THE ROOF AND GRADUALLY DRAINS WITHOUT OVERLOADING THE STORM SEWER SYSTEM.

THE SPECIALLY DESIGNED PARABOLIC OPENING OF THE ACCUTROL WEIR CREATES A CONSTANT FLOW OF RAINWATER THAT INCREASES PROPORTIONATELY AT A RATE OF 5 GPM PER INCH OF STANDING WATER UP TO 30 GPM ON THE R1200 SERIES AND 20 GPM ON THE R1100 SERIES.




**Controlled Flow Roof Drainage: Design Considerations.**

Three main considerations must guide the design of a controlled flow roof drainage system:

1. It must drain quickly enough to avoid the weight of water building to the point of being an architectural hazard.
2. It must drain slowly enough to prevent overloading the sewage system with the consequent risk of flooding or pollution or both.
3. It must drain down in a reasonable time to minimize the risk of freezing in low temperatures.

To meet these requirements, regional rainfall values had to be carefully considered. From these values, it is possible to calculate the number of gallons per minute (GPM) need to be drained to ensure the buildup in the worst conditions did not exceed a depth of three inches. The consideration of the worst conditions had to be determined from government statistics. The figures used were compiled by the Meteorological Branch of the Department of Transport. The information was combined to produce values that would predict the worst conditions that one could expect over a period of time, in this case ten, twenty-five and fifty years. Hence the expression, “ten year rain” or “fifty year rain”.

As well, there are also the local building codes, which specify drain down time (in hours) and maximum head of water on the roof in inches. The maximum drain down time has been determined to be 30 hours to eliminate the possibility of freezing. A constant rate of flow makes it possible, with the use of our Area Selection Table, to quickly determine the number of drains needed for any size of roof where this value is known.

**Controlled Flow Roof Drainage: Factors that can effect Roof Drain Sizing & Position.**

Where a roof area is surrounded by vertical walls, some consideration must be given to the volume of rainwater that these walls might add to the total volume to be drained under “driving rain” conditions:

1. One wall: Add 50% of wall area
2. Two walls: Add 35% of wall area
3. Two walls opposite of differing heights: Add 50% of the difference in wall area of that part which extends above the lower wall.
4. Walls on three sides: Add 50% of the inner wall area above the top of the lowest wall(s).

**Other Factors to consider:**

5. Drains should be located with preference to the downwind side of the roof. In a storm, it is not uncommon for the rainwater level to differ significantly from one side to another due to the effects of high winds.
6. Drains should not be located at columns or other high spots.
7. Rooftop mechanical equipment shall be installed with proper allowances for the “ponding” a control flow roof drain system will create.
8. Parapets should be high enough to prevent spillage or worse, for in winter there is the danger of ice or snow blowing off the road that must be considered.

**Controlled Flow Roof Drainage: Sizing Procedure.**

**A** Determine the roof area(s) (individual areas when the roof is divided by expansion joints, parapet walls, control joints, etc.) to be drained making the allowances for any of the factors (above) which may effect the total square footage of the roof.

**B** Follow the location and placement guidelines for conventional roof drains as found on the next pages (viii & ix), allowing no more than 50 ft. from an edge, no more than 100 ft. apart, and a maximum square footage of 10,000 per drain, etc.

**C** Calculate the number of weirs. Divide the total square footage by the area factor (from chart below) for the location of the roof. If the number of weirs is greater than the number of drains from **step B**, add 2-slot weirs to roof drains as necessary, starting with the drains closest to the downwind edges of the roof. If the number of weirs is fractional, round up. If the number of weirs is less than the number of drains, every drain should still be equipped with a one slot weir.

**D** Based on the slope and area to be drained by each weir, the maximum flow from all the drains on the roof (see chart below) can be added together to determine vertical leader sizing and horizontal storm sewer requirements.

# ACCUFLOW AREA SELECTION TABLE

| | | | ROOF AREA TO BE DRAINED BY ONE WEIR OPENING | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2500 sq. ft. | | | 5000 sq. ft. | | | 7500 sq. ft. | | | 10,000 sq. ft. | | |
| LOCALITY | Area Factor | Roof Rise (in.) | Max. flow G.P.M. | Draindown time (hrs.) | Max head (in.) | Max. flow G.P.M. | Draindown time (hrs.) | Max. head (in.) | Max. flow G.P.M. | Draindown time (hrs.) | Max. head (in.) | Max. flow G.P.M. | Draindown time (hrs.) | Max. head (in.) |
| | | 0 | 10.50 | 7.50 | 2.10 | 13.50 | 18.00 | 2.70 | 15.25 | 27.00 | 3.05 | 17.00 | 40.00 | 3.40 |
| Halifax, N.S. | 3500 | 2 | 13.50 | 6.50 | 2.70 | 16.50 | 16.00 | 3.30 | 18.25 | 25.00 | 3.65 | 19.50 | 34.00 | 3.90 |
| Hamilton, Ont. | 6700 | 3 | 14.25 | 5.00 | 2.85 | 17.75 | 12.00 | 3.55 | 20.00 | 20.00 | 4.00 | 21.25 | 28.00 | 4.25 |
| London, Ont. | 6700 | 4 | 16.25 | 4.00 | 3.25 | 19.75 | 10.00 | 3.95 | 21.75 | 17.00 | 4.35 | 23.25 | 24.00 | 4.65 |
| Toronto, Ont. | 6700 | 5 | 17.50 | 3.50 | 3.50 | 21.00 | 8.20 | 4.20 | 23.25 | 14.00 | 4.65 | 25.00 | 21.00 | 5.00 |
| Windsor, Ont. | 6700 | 6 | 18.50 | 3.00 | 3.70 | 22.50 | 7.80 | 4.50 | 25.00 | 13.00 | 5.00 | 26.50 | 19.00 | 5.30 |
| Calgary, Alberta | 6700 | 0 | 10.50 | 7.50 | 2.10 | 13.50 | 18.00 | 2.70 | 15.25 | 27.00 | 3.05 | 17.00 | 40.00 | 3.40 |
| Edmonton, Alberta | 8000 | 2 | 13.50 | 6.50 | 2.70 | 16.50 | 16.00 | 3.30 | 18.25 | 25.00 | 3.65 | 19.50 | 34.00 | 3.90 |
| Regina, Sask. | 6700 | 3 | 14.25 | 5.00 | 2.85 | 17.75 | 12.00 | 3.55 | 20.00 | 20.00 | 4.00 | 21.25 | 28.00 | 4.25 |
| Moncton, N.B. | 3500 | 4 | 16.25 | 4.00 | 3.25 | 19.75 | 10.00 | 3.95 | 21.75 | 17.00 | 4.35 | 23.25 | 24.00 | 4.65 |
| St. John's, Nfld. | 5000 | 5 | 17.50 | 3.50 | 3.50 | 21.00 | 8.20 | 4.20 | 23.25 | 14.00 | 4.65 | 25.00 | 21.00 | 5.00 |
| Saskatoon, Sask. | 6700 | 6 | 18.50 | 3.00 | 3.70 | 22.50 | 7.80 | 4.50 | 25.00 | 13.00 | 5.00 | 26.50 | 19.00 | 5.30 |
| Montreal, Que. | 6700 | 0 | 13.50 | 9.00 | 2.70 | 16.00 | 20.00 | 3.20 | 17.50 | 32.00 | 3.50 | 19.00 | 42.00 | 3.80 |
| Quebec, Que. | 5000 | 2 | 17.00 | 8.00 | 3.40 | 19.25 | 17.00 | 3.85 | 20.50 | 27.00 | 4.10 | 21.50 | 38.00 | 4.30 |
| Kingston, Ont. | 6700 | 3 | 18.00 | 6.00 | 3.60 | 20.50 | 14.00 | 4.10 | 21.75 | 22.00 | 4.35 | 22.50 | 29.00 | 4.50 |
| Saint John, N.B. | 3500 | 4 | 20.25 | 5.00 | 4.05 | 22.75 | 12.00 | 4.55 | 24.25 | 19.00 | 4.85 | 25.50 | 27.00 | 5.10 |
| | | 5 | 22.50 | 4.50 | 4.50 | 22.50 | 10.00 | 5.10 | 27.25 | 17.00 | 5.45 | 28.00 | 23.00 | 5.60 |
| | | 6 | 24.00 | 4.00 | 4.80 | 27.00 | 9.50 | 5.40 | 28.75 | 15.00 | 5.75 | 30.00 | 21.00 | 6.00 |
| Vancouver, B.C. | 6700 | 0 | 7.25 | 5.50 | 1.45 | 8.50 | 13.00 | 1.70 | 9.50 | 22.00 | 1.90 | 10.00 | 29.00 | 2.00 |
| | | 2 | 8.25 | 4.00 | 1.65 | 10.00 | 10.00 | 2.00 | 11.00 | 16.00 | 2.20 | 11.50 | 23.00 | 2.30 |
| Victoria, B.C. | 6700 | 3 | 8.75 | 3.00 | 1.75 | 10.50 | 7.50 | 2.10 | 11.75 | 12.00 | 2.35 | 12.50 | 17.00 | 2.50 |
| | | 4 | 9.50 | 2.50 | 1.90 | 11.50 | 6.00 | 2.30 | 13.00 | 10.00 | 2.60 | 14.00 | 14.00 | 2.80 |
| | | 5 | 10.75 | 2.10 | 2.15 | 13.25 | 5.30 | 2.65 | 14.75 | 9.00 | 2.95 | 15.75 | 13.00 | 3.15 |
| | | 6 | 12.25 | 2.00 | 2.45 | 15.00 | 5.00 | 3.00 | 16.50 | 8.50 | 3.30 | 17.50 | 12.00 | 3.50 |
| Ottawa, Ont. | 8300 | 0 | 10.50 | 7.50 | 2.10 | 13.00 | 17.00 | 2.60 | 14.25 | 28.00 | 2.85 | 15.00 | 39.00 | 3.00 |
| Winnipeg, Man. | 6700 | 2 | 13.25 | 6.50 | 2.65 | 15.50 | 15.00 | 3.10 | 17.25 | 24.00 | 3.45 | 18.25 | 32.00 | 3.65 |
| Thunder Bay, Ont. | 6700 | 3 | 15.00 | 5.00 | 3.00 | 17.50 | 12.00 | 3.50 | 18.75 | 19.00 | 3.75 | 20.00 | 26.00 | 4.00 |
| | | 4 | 16.25 | 4.00 | 3.25 | 18.75 | 10.00 | 3.75 | 20.25 | 16.00 | 4.05 | 21.50 | 22.00 | 4.30 |
| | | 5 | 18.25 | 3.80 | 3.65 | 21.25 | 8.50 | 4.25 | 23.00 | 14.00 | 4.60 | 24.25 | 20.00 | 4.85 |
| | | 6 | 19.50 | 3.30 | 3.90 | 22.50 | 8.00 | 4.50 | 24.25 | 12.50 | 4.85 | 25.50 | 18.00 | 5.10 |
| | | 0 | 12.00 | 8.00 | 2.40 | 14.00 | 19.00 | 2.80 | 15.00 | 29.00 | 3.00 | 16.25 | 40.00 | 3.25 |
| Guelph, Ont. | 6700 | 2 | 15.00 | 7.00 | 3.00 | 17.00 | 16.00 | 3.40 | 18.25 | 25.00 | 3.65 | 19.00 | 33.00 | 3.80 |
| St. Thomas, Ont. | 6700 | 3 | 16.75 | 5.80 | 3.35 | 19.00 | 13.00 | 3.80 | 20.00 | 20.00 | 4.00 | 21.00 | 27.00 | 4.20 |
| North Bay, Ont. | 6700 | 4 | 18.75 | 4.80 | 3.75 | 21.25 | 11.00 | 4.25 | 22.50 | 17.00 | 4.50 | 23.50 | 24.00 | 4.70 |
| | | 5 | 20.75 | 4.10 | 4.15 | 23.50 | 9.50 | 4.70 | 25.00 | 15.50 | 5.00 | 26.00 | 21.00 | 5.20 |
| | | 6 | 22.75 | 3.80 | 4.55 | 26.00 | 9.00 | 5.20 | 27.50 | 14.00 | 5.50 | 29.00 | 20.00 | 5.80 |

**Controlled Flow Roof Drainage: Example.**
**80,000 sq. ft. (200 x 400) flat roof building in Ottawa, Ontario, no appreciable vertical surface additions.**
Conventional sizing places 8 drains on the roof (see conventional sizing and placement). The area factor for Ottawa is 8300 (80,000÷8300=9.63) or 10 weirs; size 1-weir roof drains and two 2-weir drains. From the Area selection table, we see that the maximum expected flow will be 15 GPM per weir or 150 GPM for the whole roof. Using Chart A on pg viii, a **4" vertical leader** is required (192 GPM capacity) and a **5" storm sewer pipe** (at 1/4" slope. See Chart B on pg. ix). Compare this to the conventional system which requires **8" vertical leaders and a 15" storm drain** for the same size roof. In this way, controlled flow systems are more economical, requiring overall reduced pipe sizes compared to conventional roof drain systems.

# Sizing and Placement of MIFAB Roof Drains

As a first step in the sizing procedure it will be necessary to determine the quantity and placement of the drains required for the roof. Even though there are a number of opinions regarding roof areas that can be effectively drained by one drain, it is recognized that for minimized ponding with adequate drainage, two roof drains are required for roof areas of 10,000 square feet or less, and at least one drain is required per 10,000 square feet of area for larger roofs. Individual judgement will be necessary when considering quantity and placement of drains on roofs where shape and size of sections may require departure from the 10,000 square feet per drain recommendation. In the replacement of drains, uniform distribution is desirable for proper roof drainage. Locating drains within 50 feet of the roof perimeter and no more than 100 feet apart is acceptable practice. Also, careful consideration of roof structural members, dividers, expansion joints, and other projections including rooftop equipment is essential in planning the roof drainage system for adequate drainage of each area of the roof. Consultation with the architect and structural engineer regarding roof details is recommended.

**RAINFALL CONVERSION:**
**INCHES PER HOUR TO GPM**

For sizing purposes, rainfall-which is expressed in inches per hour, (in the following calculation) - is converted to gallons per minute per square foot of roof area. A one (1) inch per hour rainfall converts to .0104 GPM per square foot. For any given rainfall, multiply the inches per hour by .0104 to arrive at the GPM per square foot of roof area. Then multiply that figure by the square feet of roof area to be drained to arrive at the total gallons per minute to be handled by the drainage system.

**For example: consider a 4-inch per hour rainfall on a 10,000 square foot roof:**

**0.0104x4x 10,000 = 4l6 GPM**

**• CHARTS A AND B**

As an aid to the sizing and placement of MIFAB roof drains, please refer to Charts A and B, which give leader and horizontal storm drain capacities at various slopes, with capacities in GPM and maximum projected roof areas in square feet in each case. It will be noted that a 6-inch leader, thus 6-inch drain, will be indicated by the preceding example. The horizontal storm drain required, depending on slope, would be 6 or 8 inch. However, remembering that two drains are recommended for areas of 10,000 square feet or less, it would be advisable to select smaller drains with total capacity of 416 GPM or more. The maximum projected roof areas in Charts A and B are based on the flow capacity of each pipe size shown. The total of the projected flows from the vertical leaders will determine the size and slope of the horizontal storm sewer required in chart B.

**CHART A:**
VERTICAL LEADER CAPACITY IN GPM WITH MAXIMUM SERVICEABLE ROOF AREA IN SQUARE FEET BASED ON VARIOUS ANTICIPATED HOURLY RAINFALL RATES

| VERTICAL LEADER SIZE | CAPACITY (GPM) | Roof Area | Roof Area | Roof Area | Roof Area | Roof Area | Roof Area |
|---|---|---|---|---|---|---|---|
| RAINFALL INCHES PER HOUR → | | 1 | 2 | 3 (Square Feet) | 4 | 5 | 6 |
| 2 | 30 | 2880 | 1440 | 960 | 720 | 575 | 480 |
| 3 | 92 | 8800 | 4400 | 2930 | 2200 | 1760 | 1470 |
| 4 | 192 | 18400 | 9200 | 6130 | 4600 | 3680 | 3070 |
| 6 | 563 | 11600 | 2700 | 17995 | 13500 | 10800 | 9000 |
| 8 | 1208 | 116000 | 58000 | 38660 | 29000 | 23200 | 19315 |

# Sizing and Placement of MIFAB Roof Drains

**CHART B:**
HORIZONTAL STORM DRAIN CAPACITY IN GPM FOR SLOPES GIVEN WITH MAXIMUM SERVICEABLE ROOF AREA IN SQUARE FEET BASED ON SYSTEM CAPACITY

| | 1/8 INCH PER FOOT SLOPE | | 1/4 INCH PER FOOT SLOPE | | 1/2 INCH PER FOOT SLOPE | |
|---|---|---|---|---|---|---|
| DRAIN PIPE SIZE (INCHES) | DRAIN CAPACITY (GPM) | MAXIMUM ROOF AREA (SQUARE FEET) | DRAIN CAPACITY (GPM) | MAXIMUM ROOF AREA (SQUARE FEET) | DRAIN CAPACITY (GPM) | MAXIMUM ROOF AREA (SQUARE FEET) |
| 3 | 34 | 822 | 48 | 1160 | 69 | 1644 |
| 4 | 78 | 1880 | 110 | 2650 | 157 | 3760 |
| 5 | 139 | 3340 | 197 | 4720 | 278 | 6680 |
| 6 | 223 | 5350 | 315 | 7550 | 446 | 10700 |
| 8 | 479 | 11500 | 679 | 16300 | 958 | 23000 |
| 10 | 863 | 20700 | 1217 | 29200 | 1725 | 14100 |
| 12 | 1388 | 33300 | 1958 | 47000 | 2775 | 66600 |
| 15 | 2479 | 59500 | 3500 | 84000 | 4958 | 11900 |

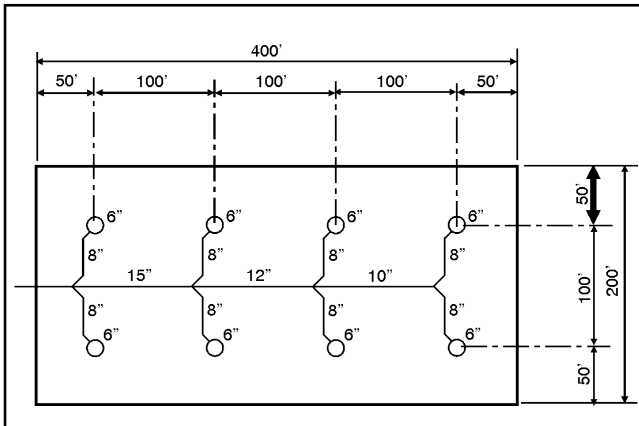
# Roof Drain Sizing - Example

A warehouse is being built in a geographical area where the maximum hourly rainfall (See Page RD-6) is 2.8 inches per hour. The building will be 200'x400' and have a flat roof with no appreciable vertical surfaces.

**C A L C U A T I O N S:**

- Total area to be drained (200 x 400) **80,000 Sq. ft.**
- Number of drains required **8**
  (From sizing rule, one drain per 10,000 sq. Ft.)
- Rainfall conversion from in. per hour to GPM **2330**
  (0.0104 x 2.8 x 80,000)
- Expected flow from drain **292**
  (GPM ÷ number of drains) (2330 ÷ 8)
- Size of leader (from Chart A) **6 inch vertical**
- Size of horizontal storm sewers
  (from Chart B 1/4/ foot slope,
  combined flow of vertical leaders) **8,10,12,15 inches**

**Roof Drainage System Layout indicated by the sizing example**




# Roof Drain Sizing: Other Considerations

**• OVERFLOW DRAINAGE**
Overflow scuppers and drains, as essential components of the roof drainage system, are employed to prevent potentially damaging overloading of roof structures. They must be installed in conformance with local codes. Generally, scuppers are installed in adjacent parapet walls no more than 5 inches above the low point of the roof at a ratio of at least one scupper per 20,000 sq. ft. of roof area. Overflow drains of the same size as the roof drains having above roof inlet elevation as specified by code, connected to drain lines independent from the roof drains, may be installed in lieu of scuppers.

**• VERTICAL WALLS**
Finally, vertical walls that project above and permit storm water to drain on the roof area to be drained must be considered when planning the roof drainage system. An acceptable rule to follow in sizing roof drains, leaders, and horizontal drainage piping is to add one half of the area of any vertical wall that diverts rainwater to the roof to the projected area of that roof. By multiplying the area thus obtained by the GPM/sq. ft. conversion of inches per hour rainfall, the new total GPM discharge requirement is determined for the roof.